United States Patent [19]

Kaufman

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[45] **Dec. 11, 1973**

[54] **SPRAY BOOTH AND SYSTEM**

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[21] Appl. No.: **209,951**

[52] **U.S. Cl.** **118/603,** 118/312, 118/326, 118/634, 118/DIG. 7

[51] **Int. Cl.** **B05b 5/02**

[58] **Field of Search** ..... 118/DIG. 7, 326, 118/634, 603, 312, 308; 51/12, 8; 98/115 SB

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Attorney—Dominik, Knechtel & Godula

[57] **ABSTRACT**

A spray booth having a double bottomed inverted pyramidal portion with the vertex thereof truncated to provide for the flow of air and collection of dust particles in which an air flow is provided interiorly of the double wall to thereby provide a curtain of air in front of the open portions of the spray booth and co-act with the opening in the bottom to remove fine particles sprayed within the booth. Four sidewalls extend above the four sided pyramidal hopper, one-fourth of which is open either as a complete missing sidewall of missing panels from usually opposed sidewalls to accommodate the passage of product targets to be coated. A T-shaped bottom connection appears on the pyramidal inverted hopper for quick cleaning when changing colors, and the passage of the air and particles to a filter bag chamber and thence to the suction blower which may include a return system for closed circuit operation.

8 Claims, 19 Drawing Figures

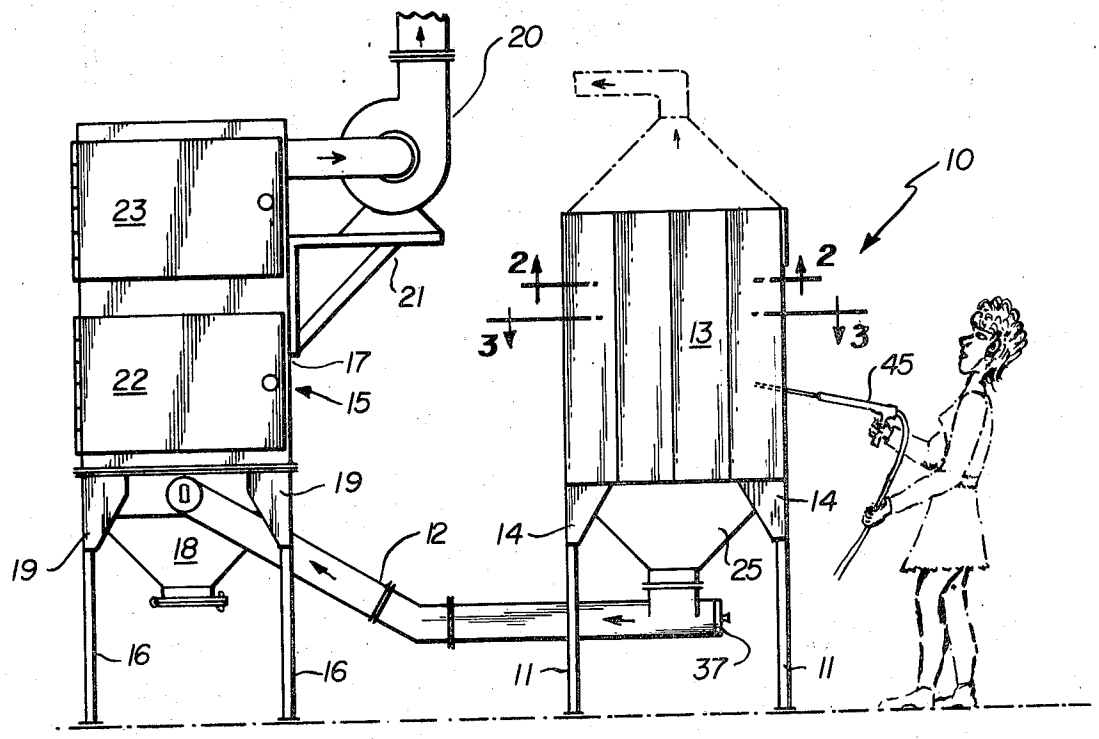


FIG. 1

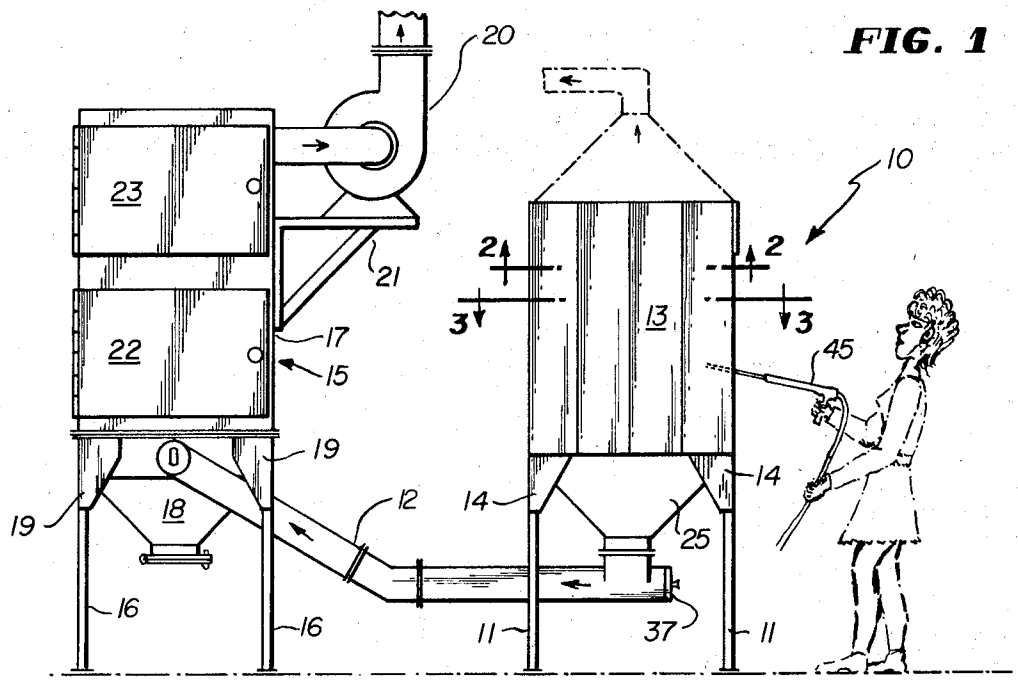


FIG. 2

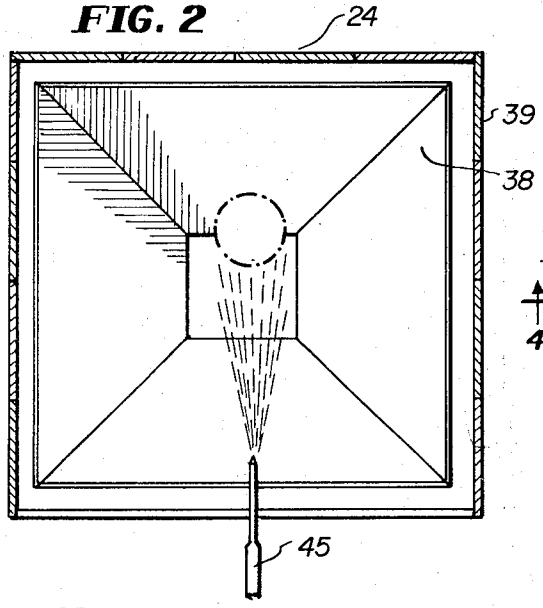
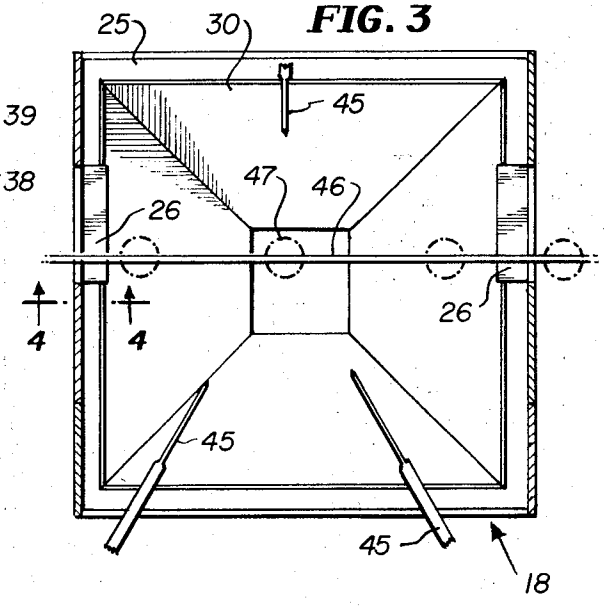


FIG. 3



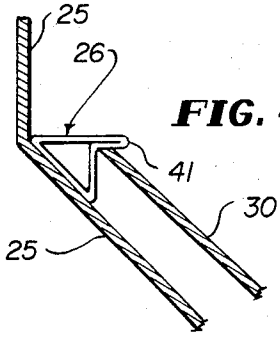


FIG. 4

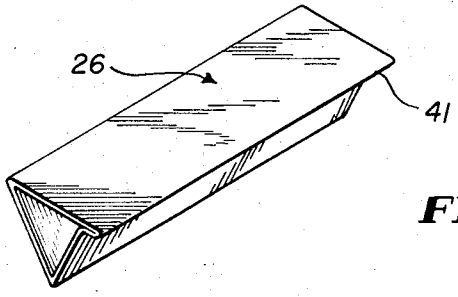


FIG. 5

FIG. 6

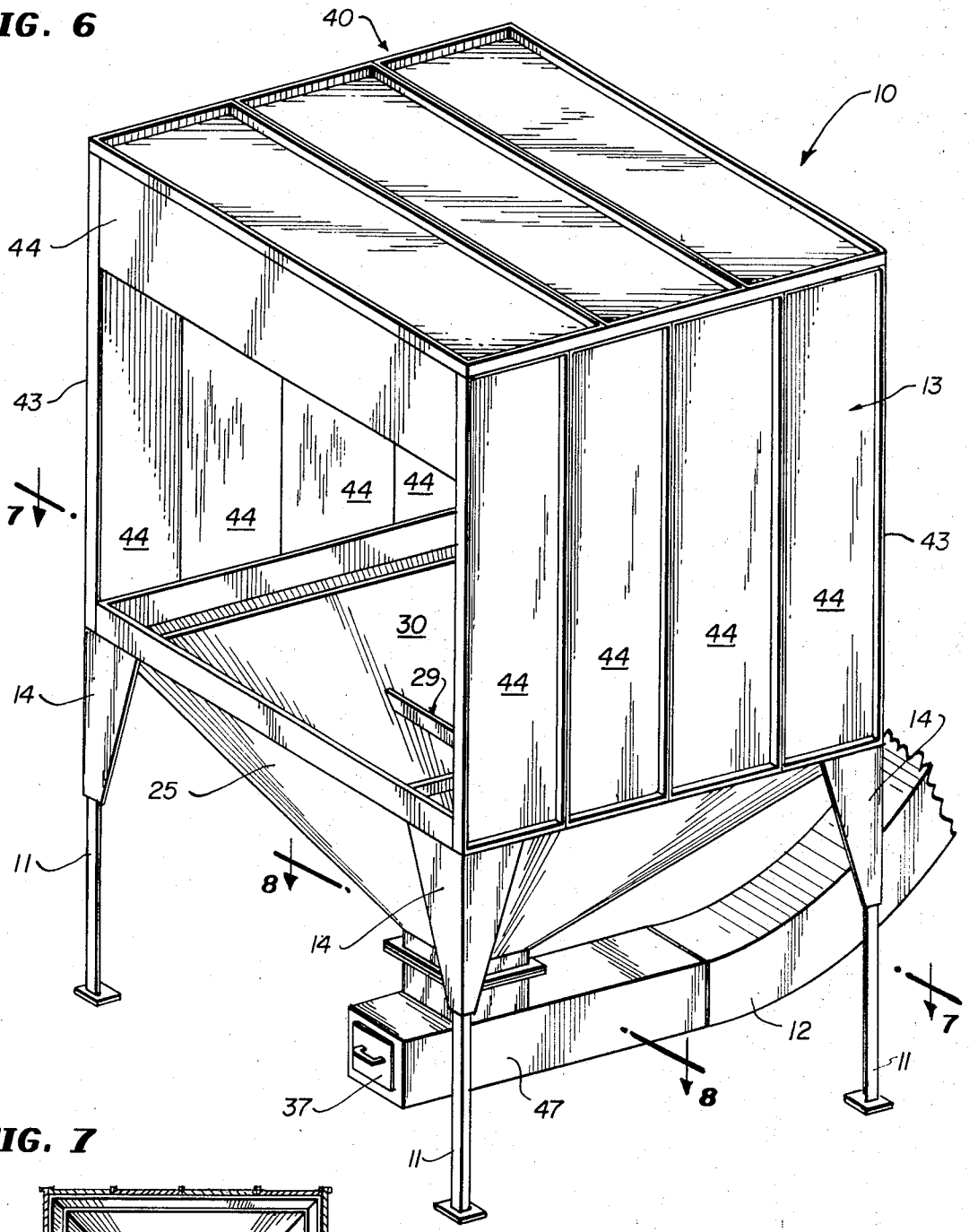


FIG. 7

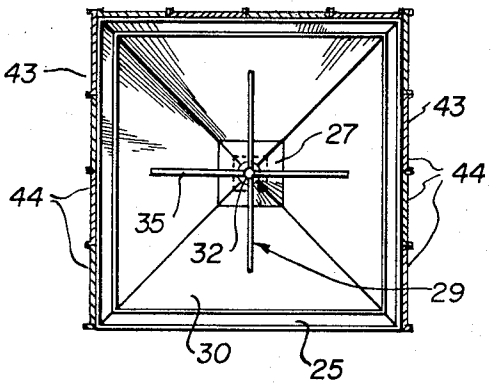


FIG. 8

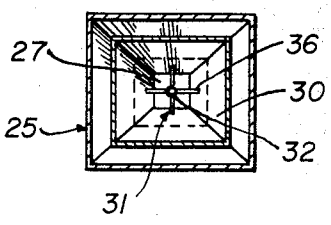
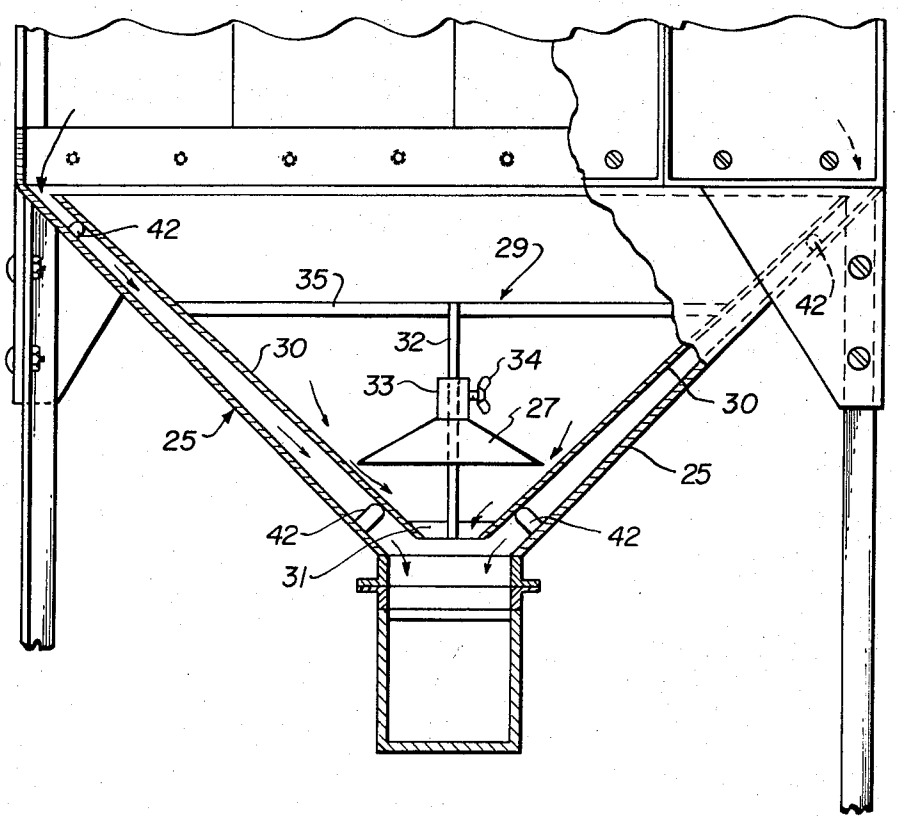


FIG. 9



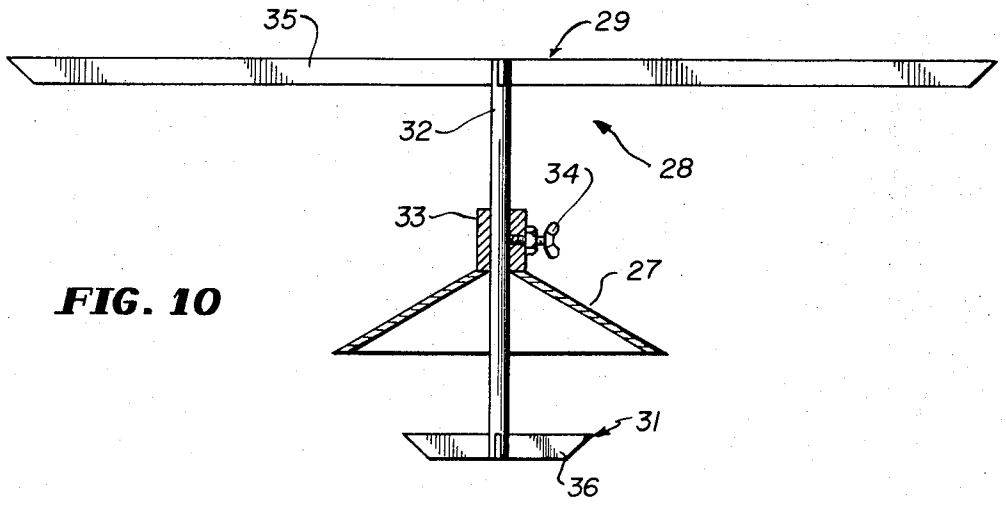


FIG. 10

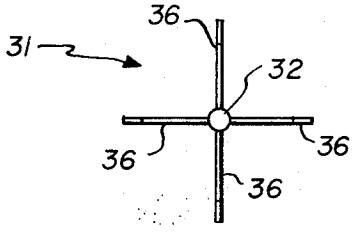


FIG. 11

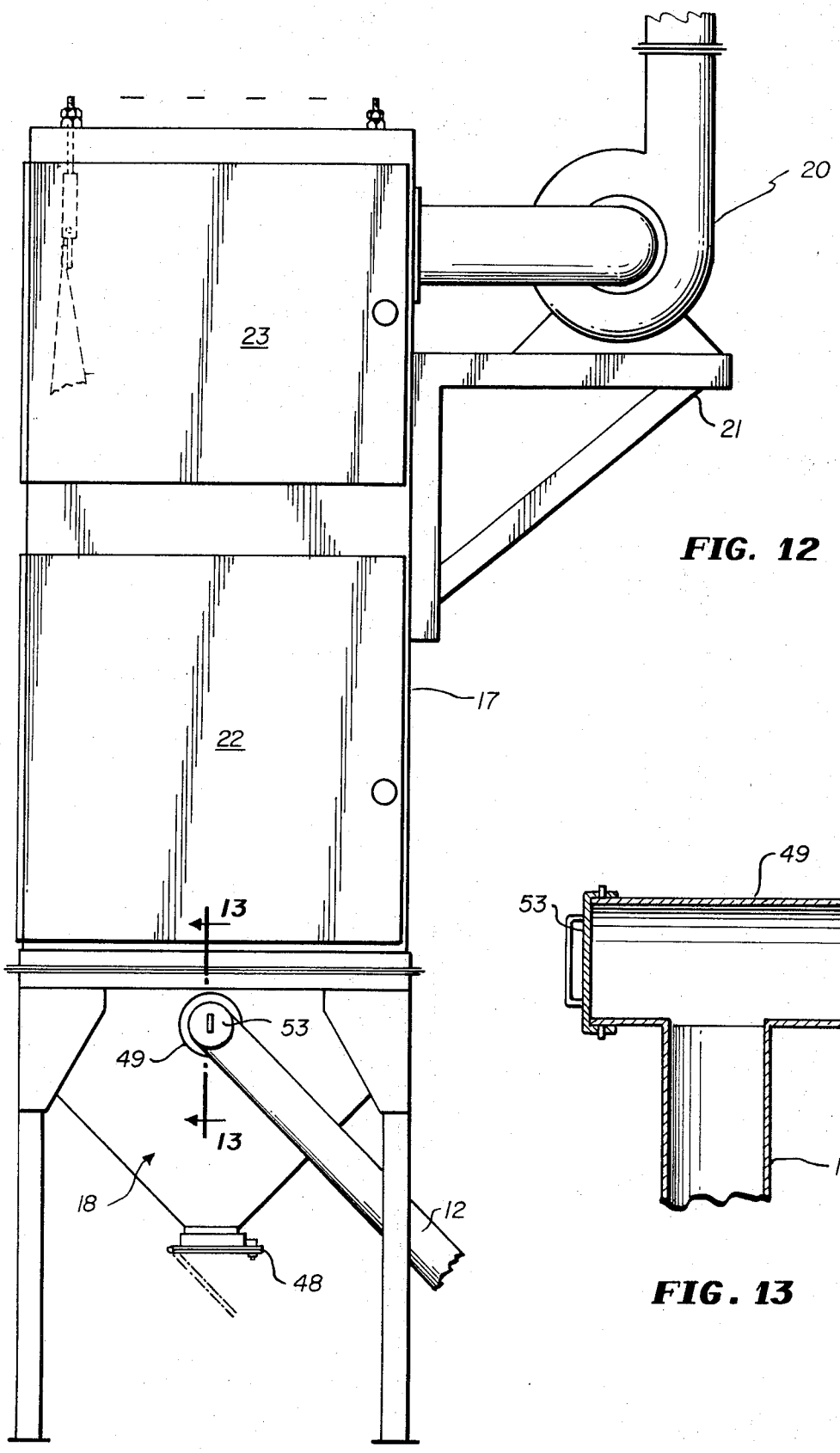


FIG. 12

FIG. 13

FIG. 14

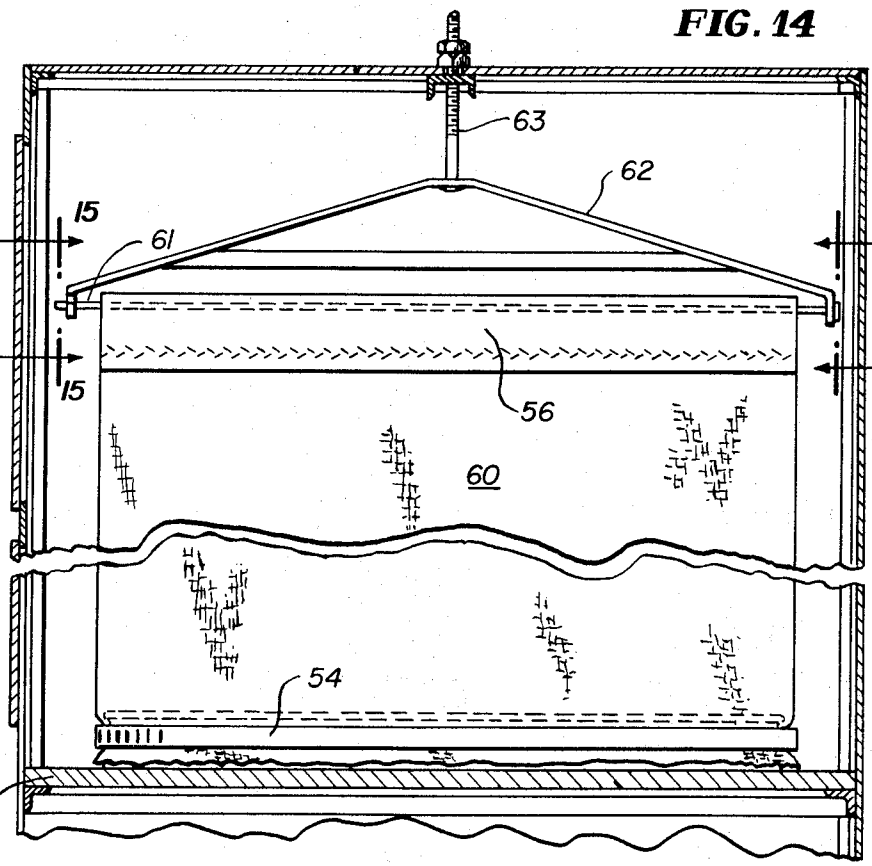


FIG. 15

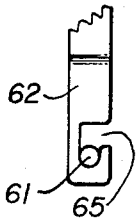


FIG. 16

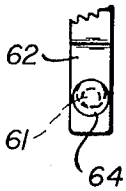


FIG. 18

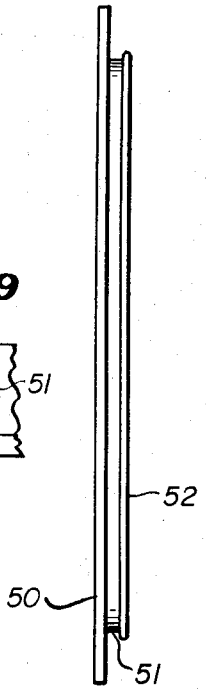


FIG. 17

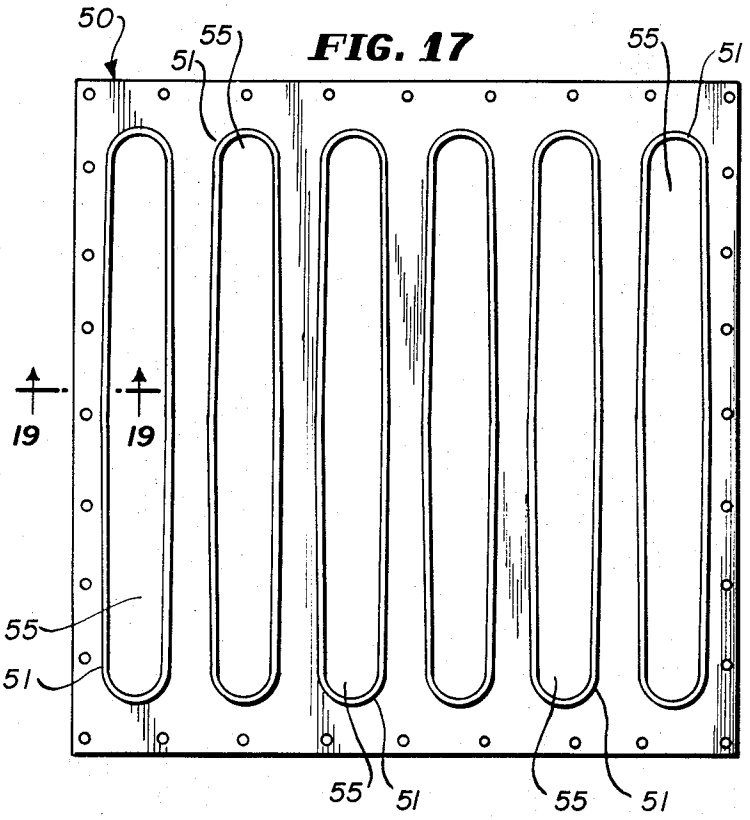
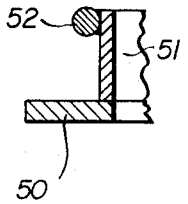


FIG. 19



SPRAY BOOTH AND SYSTEM

FIELD OF INVENTION

The present invention relates to a spray booth and system, and more particularly that type of spray booth which is employed in electrostatic dry coating in which the product target is sprayed with an electrostatically charged plurality of particles which are thereafter fired in an oven to coat or "paint" the same.

DESCRIPTION OF PRIOR ART

The principal prior art is well known, namely spray booths for solvent paint spraying. In most such spray booths four sides are provided with one side being open. One of the sides, usually the rear, may contain a plurality of baffles or filters to filter the solvent and solids from the sprayed atmosphere and exhaust the same. A Berridge-type spray booth has been known, manufactured and sold in England, in which a rounded hopper is at the bottom of a three-sided unit in which the front side is open. In the Berridge unit, when used with an electrostatic dry powder gun, the majority of the air in the area is drawn down across the face of the booth opening into a 1 inch to 2 inch duct opening across the top of the lower half of the booth opening. This Y-shaped duct is enclosed, except for the top opening, and continues under the rounded bottom and up the back wall where there is a small opening covered by a baffle plate extended out from the opening approximately 1 inch to utilize the remainder of the air to draw off the finer particles in the oversprayed powder. This baffle plate does act as a buffer to the air so the part being coated is not adversely effected by the air stream. The duct continues up and into the cloth sleeve (not bags) house. This house is attached and part of the overall unit, cannot be moved, and takes up the entire back of the spray booth. Thus one cannot mount guns or manually spray from the back as well as the front. This is a must when spraying large flat surfaces. Also while spraying in the Berridge, the majority of the oversprayed powder particles will settle and build up in the bottom of the booth. These bottom and rear panels covering the duct are difficult to reach and lift out to permit this build-up of powders to continue on to the collection house. When spraying, the lighter powder particles are carried into the collection house and when one stops to clean out the heavier particles they are carried to the collection house so one must mix the powder particles before reusing. Also when removing the side panels of the booth to permit a conveyor to be used, there is no place to attach them to the front so consequently the CFM (air to cloth ratio) is upset with a loss of efficiency. Because of the possibility of operating the booth without side panels, a more powerful motor and exhauster is used resulting in higher noise levels.

SUMMARY

The invention is directed in one aspect to the provision of a double bottomed pyramidal inverted hopper in a spray booth generally having four sides, one of which is open, and separating the double bottom in such a fashion that around the four upper edges of the inverted pyramidal bottom a uniform curtain wall of moving air is directed downwardly into the chamber thus defined between the two portions of the double bottom. At the lower portion of the inverted pyramidal double bottom an opening is provided in closed circuit relationship with a vacuum or reduced pressure tube, preferably connected to a T-shaped head adjacent the bottom which provides the vacuum or reduced pressure to generate the curtain wall as well as the T-shaped unit providing for quick cleaning of the dust which is carried through the system. A flow control canopy is adjustably positioned above the opening at the bottom of the hopper. The inner hopper is readily removable for cleaning, as can also be the flow control canopy and its support.

The system includes the double bottomed hopper and booth in combination with a bag collection system with a removable hopper at the bottom and the bags being readily removable for shaking, cleaning, and color changing; the vacuum being provided at the top by a blower, the exhaust from which may be used in closed circuit relationship with the booth.

One of the principal objects of the present invention is to provide a double bottomed spray booth in which the recovery of electrostatic dry spray approaches 100 percent, and contamination is minimized by a curtain wall of air.

A related and also important object of the invention is to provide a double bottomed spray booth in which the airflow is at the sidewall portions thereby rendering the center target area relatively free from air currents and burbles, thus permitting an even and effective distribution of the dry spray electrostatic coating without interference from the ambient air, including the factory air at the open portion.

Still another object of the present invention is to provide a double bottomed spray booth and system which, when changing from one color to another, can be readily cleaned and made available for the new color without contamination from the older, and yet preserve a high percentage of recovery of that portion of the dry coating which has not adhered to the target.

Still another object of the present invention is to provide a spray booth and system in which the parts are so modularized that they can be flexibly located throughout a plant site to not only accommodate the physical confines of an existing plant for installation, but also accommodate local codes with regard to exhaust systems and their respective locations.

Still another object of the present invention is to provide a spray booth and system of the character set forth above which is readily disassembled for shipment, inherently low in cost, and yet high in recovery efficiency and utilization effectiveness.

Another and more detailed object of the present invention is to provide a spray booth which is readily adaptable to existing oven and conveyor systems to convert an existing operation from wet or solvent paint spraying to dry electrostatic spraying and coating.

DESCRIPTION OF DRAWINGS

Further objects and advantages of the present invention will become apparent as the following description proceeds, taken in conjunction with the illustrative drawings in which:

FIG. 1 is a front elevation of an electrostatic spray booth installation and powder collecting system.

FIG. 2 is a transverse sectional view taken through section line 2—2 of FIG. 1 showing a single suspended part.

FIG. 3 is a transverse sectional view taken through section line 3—3 of FIG. 1 looking downwardly on a plurality of parts being run through the spray booth by a conveyor, and illustrating the positioning of the blockers.

FIG. 4 is an enlarged partially transverse cut-out view taken through section line 4—4 of FIG. 3 showing the blocker in place between the outer hopper and inner hopper.

FIG. 5 is a perspective view of the blocker.

FIG. 6 is an enlarged view of a modified spray booth having a flat top or ceiling, illustrating partially the positioning of the spider support for the flow control panel on the inner hopper.

FIG. 7 is a transverse sectional view taken through section line 7—7 of FIG. 6 illustrating the position of the canopy support hopper for removable insertion in the inner hopper in the spray booth.

FIG. 8 is an enlarged transverse sectional view taken through section line 8—8 of FIG. 6 illustrating in particular the bottom support for the mechanism for adjustably supporting the flow control canopy.

FIG. 9 is a front elevation, partially broken and partially sectioned, of the spray booth illustrating the flow control canopy and its relationship between the double bottom unit, and its support in place.

FIG. 10 is an enlarged view, partially cut, showing the flow control canopy and its upper and lower spides for removal and control.

FIG. 11 is a bottom view of the bottom spider of the flow control canopy support structure shown in FIG. 10.

FIG. 12 is a front elevation of the dust collector showing the upper and lower cabinet portions.

FIG. 13 is an enlarged transverse sectional view of the exhaust pipe from the spray booth and its connection to the lower portion of the dust or powder collector.

FIG. 14 is an enlarged transverse section of the dust collector illustrating, in broken form, a single large bag employed in the same for collecting the dust.

FIG. 15 is an enlarged broken view taken from the position shown at 15—15 in FIG. 14 illustrating the hanger support for the upper hanger rod of the bag.

FIG. 16 is an enlarged partially broken view taken from the opposite end of the bag support shown at 16—16 on FIG. 14.

FIGS. 17, 18, and 19 show details of the cell plate for mounting the dust collecting bags.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENT

Referring to FIG. 1, the general assembly of the spray booth 10 will be observed. There it will be seen that the spray booth 10 is mounted atop a plurality of legs 11, and connected by means of a spray booth exhaust pipe 12 to a recovery cabinet 15. The spray booth legs 11 are secured by means of mounting gussets 14 to the bottom of the spray booth upper cabinet 13, thereby improving the portability of the unit. Similarly, the recovery cabinet 15 is supported on four legs 16, the same being secured in place removably by means of the mounting gusset 19. The recovery cabinet 15 has, at its lower portion, a recovery hopper 18 in which the dust ultimately collects, or the particles of paint. Atop the recovery hopper 18 are a lower bag door 22 and an upper bag door 23 which lead to the recovery bags 60, to be explained in greater detail hereinafter. Further, it will be noted that an exhaust blower 20 is positioned at an upper portion on the blower support 21, and connected by means of a pipe, or direct connection to the upper portion of the bag cabinet 17 to draw air from around the bags, and then direct the same either by means of a closed system back into the spray booth 10, run the same through a further recovery unit or dispersion element into the plant environment, or deliver the same to the outside, depending upon the preference of the operator. Further to be observed is the cleaning cap 37 at the bottom of the T-shaped connector beneath the hopper 25 on the spray booth 10 which assists in cleaning out the exhaust pipe 12 and the balance of the booth 10 when colors are being changed.

Referring now to FIG. 2, it will be seen that the upper portion of the unit contains an inner hood 38 and an outer hood 39. The target being sprayed by the spray gun 45 is suspended from the top of the inner hood 28. Alternatively, when a target 47 is positioned on a conveyor line 46, such as shown in FIG. 3, wall panels may be removed and, to protect from air disturbance immediately above the target 47, a blocker 26 is positioned in the gap between the inner booth hopper bottom and the outer hopper bottom. The blocker element, as shown particularly in FIG. 4, is generally triangular in cross section with a support lip 41 for removably securing the same in the gap between the outer hopper 25 and inner hopper 30 particularly as shown in FIG. 4. While the blocker 26, as shown in FIG. 5, appears to be formed from a single piece of metal secured at the support lip 41, it will be appreciated that various techniques of forming the blocker 26 may be employed and, indeed, the blocker may take varying configurations. The principal function of the blocker, however, must be to block out a particular area between the inner hopper 30 and outer hopper 25 in accordance with the particular job being run, and the air flow present at that time.

Turning now to FIG. 9, it will be seen that a flow control canopy 27 is provided adjustably above the opening at the bottom of the inner hopper 30. As illustrated by the small arrows, the key purpose of the flow control canopy 27 is to adjust the flow of air around the periphery of the flow control canopy immediately above the inner hopper 30, and more particularly above the inner hopper 30 open bottom portion.

As will be observed also in FIG. 9, the inner hopper 30 is supported on a plurality of inner hopper support studs secured to the inner face of the outer hopper 25. The relative height, type of material employed, and number of support studs depends on the size of the particular cabinet and the installation, and more particularly the material employed in the inner hopper 30. When the inner hopper 30 is made of lightweight aluminum, or plywood, it can be easily removed by one man, or even a girl operator. To further facilitate the removal of the inner hopper 30, the entire flow control canopy construction is also rendered removable. For example, it will be noted that an upper spider 29 is provided with a plurality of upper spider arms, here shown in the form of a cross, the ends of which are tapered to rest on the inner surface of the inner hopper 30. To provide additional support, and alignment for the adjustment shaft 32, a lower spider 31 is provided at the bottom portion of the shaft 32, and consists of four lower spider arms 36, tapered at their ends to set on the face of the inner hopper 30, and proportioned to rest

exactly at the opening of the bottom of the inner hopper 30. Further to be observed, a set screw 34 is provided on a slide 33 which is bored to move up and down the shaft 32, thereby permitting complete vertical adjustment of the flow control canopy 27.

As illustrated particularly in FIGS. 7 and 8, the flow control canopy 27 has a pyramidal construction. This pyramidal construction is positioned for parallel relationship to the pyramidal walls of the inner hopper 30. It will be appreciated that a circular or conical canopy will also suffice, but provide irregular gaps.

The principal elements of construction of the spray booth 10 are illustrated in FIG. 6. There it will be seen that the side walls 43 are made up of a plurality of wall panels 44. Each of the wall panels 44 is independently removable from the side wall, and from the adjacent panels. The construction and proportion of the unit is so developed that three of the four sides should be completely covered by the side wall panels 44. In varying applications, such as illustrated in FIG. 3 where a conveyor runs through the unit, and more particularly where one spray gun may be at the rear of the unit, it may be desirable to remove one side wall panel from each of two opposed sides to accommodate a conveyor. This being the case, to maintain continuity of air flow, the thus removed side wall panels 44 are most desirably positioned in front of the spray booth 10. In addition, should a spray gun 47 be positioned at the rear of the unit, the side wall panel 44 removed from the rear should also be put in the front of the spray booth 10. On such an application with three panels in the front, room can still be left for spray guns in between the same. In this fashion, as pointed out above, a wide variety of flexibility is provided both as to spray guns 47, conveyor apparatus, and the like, and yet a simple rule being followed, namely always use the same number of side wall panels 44, which preserves continuity and predetermined air flow to achieve the undisturbed target area for spraying, and yet the curtain wall for cleanliness and efficient and effective recovery. When the double walled hood 24 is employed such as shown in FIGS. 1 and 2, the number of side panels may be reduced. In certain applications, where the ambient environment is stable and relatively free of air current, the side panels may be eliminated.

Also as pointed out above, one of the important features of the present invention is the ease of cleaning the spray booth 10 when color changes are required. This is not to say that when a spray booth is set up for painting fire extinguishers, for example constant red, that cleaning is also not required. The purpose of the double bottom with the inner hopper bottom 30 being removable along with the flow control canopy assembly, makes the same easy for cleaning. Thus when the inner hopper bottom 30 is out, it can be separately cleaned by blowing, vacuum, and the like. The same applies to the flow control canopy assembly. However, once the inner hopper bottom 30 is out of place, the outer hopper bottom 25 can also be blown out, and the side walls thereby discharging the balance of the residual powder through the T-shaped connector 47 which leads to the exhaust pipe 12, and by removal of the cleaning cap 37, this area can also readily be blown out and last traces of various pigment and powders removed. It will be appreciated, of course, that flushing the air through the exhaust pipe 12 in the cleaning process will automatically pick up residuals, although vibrating the exhaust pipe 12, or even bounding the same, will also materially assist in shaking loose any fugitive particles which are to be forwarded to the recovery cabinet in the cleaning process. Throughout the entire cleaning stage, even when the inner hopper 30 is being removed as well as the flow control canopy assembly 27, the collector is operated to provide a constant flow of air at all times picking up fugitive particles of powder for delivery to the recovery cabinet. The cleaning of the recovery cabinet, and its coordinated relationship between the spray booth 10, and its cleaning will become more apparent as the description of a typical recovery cabinet proceeds.

The recovery cabinet is generally shown in FIG. 12, where it will be seen that a plurality of bags 60 (shown in phanton lines in FIG. 12) are provided inside the bag cabinet 17. The bag cabinet 17 is above a recovery hopper 18 which may open through a recovery hopper door 48 which discharges into a bin, or maybe a drawer provided therebeneath, or other mechanical expedients for receiving the particles. In addition, the recirculation may be provided from the recovery hopper door 48 back to the receptacles which feed the electrostatic guns 47.

As will be noted, there is an upper bag door 23 and a lower bag door 22. The access provided by the upper and lower bag doors will become apparent hereinafter as the description of bag removal and cleaning proceeds. Also to be noted, is the exhaust pipe 12 connection to the hopper 18, the T-shaped connection 49 being illustrated in FIG. 13, the same being provided with a cleaning cap 53 which is readily removable, and permits further inspection of dirt areas, and the ingress of air in cleaning for temporary periods to assist in the removal of all particles.

Referring now to FIG. 18, it will be seen that the bag 60 is an oblong type bag. That is to say it is relatively flat, and its width is several times its thickness, being proportioned to fit over the bag mounting collar 51 provided in the cell plate 50, as shown in FIG. 17. To secure the lower open portion of the bag 60 to the cell plate 50, the bag mounting collar 51 surrounds the bag inlet 55, and is provided at its upper portion with a band locator 52. Then as the band 54 is applied around the lower portion of the bag 60 as illustrated in FIG. 14, the bag 60 is secured in place at its lower portion in pneumatic sealed relationship with the cell plate 50.

At its upper portion, the bag 60 is provided with a tubular seam 56 to receive the hanging rod 61. A hanging rod support 62 is provided, and secured by means of a support bolt 63 at its center portion to the upper portion of the recovery cabinet. At each end of the support 62, as illustrated in FIGS. 15 and 16, means are provided for engaging the hanger rod 61. At one end of the hanger rod 61, it is provided with a head 64 (see FIG. 16) and at the other end, a key shaped crotch 65 is provided (see FIG. 15) so that upon insertion or removal of the bag 60, the free end of the hanger rod 61 is removably secured from the crotch 65, and then the bag upper portion slid over the rod, and removed, or indeed it may be shaken to drop off caked particles into the hopper, and thereby upgrade its efficiency, or alternatively clean the same for the use of a different powder.

Because of the significant over capacity available through the large size bags 60, it will be appreciated that various ones or indeed all but one of the bag inlets 55 may be capped. This is highly desirable where the

unit may be operating with three or four colors, for short periods throughout a single production day. Therefore a bag may be kept for each of the particular colors, with the other inlets **55** capped while that particular color is being run. When another color is switched to, the other bag may be placed in position while the inner and outer hopper and flow control canopy are removed for cleaning the spray booth. On the other hand, if the bags are to be sent out for processing and cleaning between colors, additional single bags can be readily positioned in place by means of the quick attach bag bottom band **54,** and the support rod **61.** Therefore various flexible elements are provided with regard to the cleaning of the bags, the changing of the bags, and the processing of various colors to the end that the down time between colors, or required between cleanings, is minimized and the manual effort as well as time for accomplishing the changes is held to a minimum. The above advantages are further highlighted when it will be appreciated that some times the spray booths and recovery chambers are used in the course of one day for running varying samples. At this time the operator may choose not to clean his spray booth or his recovery hopper or indeed remove or replace the bags **60.** Thus two or three sprays of one color of red are provided on targets followed closely thereafter by yellow, green, blue, and a whole host of colors. At the end of the day, the entire spray booth is cleaned and disassembled, the collector hopper removed, and the contents disposed of, and the single bag **60** removed and cleaned. The following day, on the other hand, may be a high production run of just one color. In order to maintain effective recovery throughout the day, all six of the recovery bags **60** may then be installed and used for the entire day. Thus it becomes apparent that the purpose principally for the cell plate **50,** and the plurality of bags **60** with their quick change hangers, is to provide the flexibility for short job runs, or long production runs, all consistent with minimized down time for cleaning.

Although particular embodiments of the invention have been shown and described in full here, there is no intention to thereby limit the invention to the details of such embodiments. On the contrary, the intention is to cover all modifications, alternatives, embodiments, usages and equivalents of a spray booth and system as fall within the spirit and scope of the invention, specification and the appended claims.

What is claimed is:

1. A spray booth, comprising in combination,

a body portion having walls,

vertical panels on said walls being removable to thereby expose the interior at an opening for the insertion of a spray gun and product targets to be sprayed,

an inverted double bottomed pyramidal hopper joining at its upper edges to the side walls of the aforesaid body,

the inner bottom terminating at its upper portion in spaced relationship to the outer bottom of said doubled walled inverted pyramidal hopper thereby defining between said bottoms a chamber through which air can pass,

an open vertex at the bottom portion of said inverted pyramidal double bottomed hopper,

equilateral openings in the upper portion of said double bottomed hopper to thereby provide for the passage of air in a uniform curtain wall to deliver the same as well as accumulated dust to the bottom of said inverted pyramidal double bottomed hopper,

a conduit positioned in pneumatically communicating cooperation with the lower portion of said inverted double bottomed pyramidal hopper to thereby, under reduced pressure, cause air to come in through the opening in the center of said inverted double bottomed pyramidal hopper as well as around the equilateral edges where the upper portion of said hopper joins the side walls,

and means for securing a target for the electrostatic deposition of powder within said spray booth,

whereby when the target is positioned within the spray booth a curtain wall of air is provided to flow down into the chamber defined between the double bottom of said inverted pyramidal hopper.

2. In the spray booth of claim **1** above,

a T-shaped connector at the lower portion of said inverted pyramidal hopper providing a reclosable opening through which air can be blown to thereby accelerate the cleaning of spray particles therefrom when the operation of the booth is shifted from one color to another or otherwise requires intermittent cleaning.

3. In the spray booth of claim **1** above,

a flow control canopy provided immediately above and in overlying relationship to the open vertex at the bottom of said inverted pyramidal double walled hopper.

4. In the spray booth of claim **3** above,

said flow control canopy being pyramidal in shape, and supported above the opening at the bottom of said double walled inverted pyramidal hopper,

said canopy being proportioned to define an adjustable opening between its edges and the base of the inverted pyramidal double walled hopper of approximately the thickness of the opening provided about the upper edge of the inverted pyramidal hopper.

5. In the spray booth of claim **4** above,

said canopy being supported by a pair of spiders, one at the bottom and one at the top,

whereby the same is held in place by gravity and easily removable.

6. A spray booth and system for use in electrostatic dry spraying comprising, in combination,

a booth having a plurality of side walls,

an inverted double bottomed pyramidal hopper at the lower portion of said booth having an opening at its lower portion,

means communicating pneumatically with the lower portion opening of said inverted double bottomed inverted pyramidal hopper to thereby provide a curtain wall around the periphery of said inverted hopper at its upper portion,

a bag extractor having a lower recovery hopper

said pneumatic communicating means which communicates with the bottom of said inverted hopper communicating directly into said recovery hopper,

a plurality of porous bags removably secured to a baffle plate positioned above said recovery hopper,

a plenum chamber in which said bags are located under negative pressure,

a blower having an inlet and exhaust, the said inlet being at reduced pressure to thereby provide a partial vacuum,

connector means in pneumatic communication with said blower inlet and the bag chamber defined above,

an exhaust from said blower directed in controlled relationship to the spray booth,

whereby a curtain wall of air is provided at the base of said booth in combination with the opening at the bottom portion of said inverted double bottomed pyramidal hopper to collect and deliver the unused particles of coating into the recovery hopper and on the interior surface of the bags and whereby upon shaking of said bags at a time when the booth is shut down or color is changed, the unused particles are available for collection and recycling in the electrostatic spray operation.

7. In the spray booth system of claim **6,**

said plenum chamber being defined by a cell plate at the bottom,

said cell plate having longitudinal bag inlets,

a bag closed at the upper end by a tubular seam with the open end conforming to the longitudinal inlets in the cell plate,

and a hanger at the top of the plenum chamber having a removable bar for passing through the bag seam for supporting the bag removably in the plenum chamber.

8. In the spray booth system of claim **6,**

a double walled hood above the double bottomed hopper,

and pneumatic conduit means connecting said blower exhaust to said hood thereby creating a positive curtain wall of air.

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